LOS COCHES TPM No. 21030
STORM WATER
MANAGEMENT PLAN

Prepared For:
THE COUNTY OF SAN DIEGO
5201 Ruffin Road, Suite B
San Diego, CA 92123

Prepared By:
Martin & Ziemniak
Civil Engineering & Land Surveying
7576 Trade Street, Suite B
San Diego, CA 92121

Prepared For:
Angel P. Antonio
7893 Prairie Shadow Drive
San Diego, CA 92126

Date:
December 14, 2007

Storm Water Management Plan
For Priority Projects
(Major SWMP)

Project Name:	**LOS COCHES TPM 21030**
Permit Number (Land Development Projects):	
Work Authorization Number (CIP):	
Applicant:	**ANGEL P. AND MARILOU S. ANTONIO**
Applicant's Address:	**7893 PRAIRIE SHADOW DRIVE** **SAN DIEGO, CA. 92126**
Plan Prepare By (*Leave blank if same as applicant*):	**MARTIN & ZIEMNIAK** **CIVIL ENGINEERING & LAND SURVEYING**
Date:	**March 20, 2007**
Revision Date (If applicable):	**December 14, 2007**

The County of San Diego Watershed Protection, Storm Water Management, and Discharge Control Ordinance (WPO) (Ordinance No. 9424) requires all applications for a permit or approval associated with a Land Disturbance Activity must be accompanied by a Storm Water Management Plan (SWMP) (section 67.804.f). The purpose of the SWMP is to describe how the project will minimize the short and long-term impacts on receiving water quality. Projects that meet the criteria for a priority project are required to prepare a Major SWMP.

Since the SWMP is a living document, revisions may be necessary during various stages of approval by the County. Please provide the approval information requested below.

Project Stages	Does the SWMP need revisions?		If YES, Provide Revision Date
	YES	NO	
TPM with associated Preliminary Grading Plan	X		December 14, 2007

Instructions for a Major SWMP can be downloaded at http://www.co.san-diego.ca.us/dpw/stormwater/susmp.html.

Completion of the following checklist and attachments will fulfill the requirements of a Major SWMP for the project listed above.

PROJECT DESCRIPTION

Please provide a brief description of the project in the following box. For example:
The 50-acre RC Ranch project is located on the south side of San Miguel Road in the County of San Diego (See Attachment 1). The project is approximately 1.0 mile east of the intersection of San Miguel Avenue and San Miguel Road and 1 mile south of the Sweetwater Reservoir. This project will consist of a planned residential community comprising of 45 single-family homes 72 and multi-unit dwellings.

The proposed 0.82-net acre Los Coches subdivision project is located on the northwest corner of the intersection of Los Coches Road and Ha Hana Road, approximately one mile northwest of interstate 8, in an unincorporated community of the County (See Attachment A) known as Los Coches. The Los Coches Subdivision will consist of splitting the 1.4-acre vacant portion of Lot 138 of Map No. 289 (Assessor Parcel Number (APN) 397-060-81) into 3 parcels varying from 0.33 acres to 0.68 acres, in order to develop three single family homes on each lot.

PRIORITY PROJECT DETERMINATION

Please check the box that best describes the project. Does the project meet one of the following criteria?

PRIORITY PROJECT	YES	NO
Redevelopment within the County Urban Area that creates or adds at least 5,000 net square feet of additional impervious surface area	X	
Residential development of more than 10 units		X
Commercial developments with a land area for development of greater than 100,000 square feet		X
Automotive repair shops		X
Restaurants, where the land area for development is greater than 5.000 square feet		X
Hillside development, in an area with known erosive soil conditions, where there will be grading on any natural slope that is twenty-five percent or greater, if the development creates 5,000 square feet or more of impervious surface		X
Environmentally Sensitive Areas: All development and redevelopment located within or directly adjacent to or discharging directly to an environmentally sensitive area (where discharges from the development or redevelopment will enter receiving waters within the environmentally sensitive area), which either creates 2,500 square feet of impervious surface on a proposed project site or increases the area of imperviousness of a proposed project site to 10% or more of its naturally occurring condition.		X
Parking Lots 5,000 square feet or more or with 15 parking spaces or more and potentially exposed to urban runoff		X
Streets, roads, highways, and freeways which would create a new paved surface that is 5,000 square feet or greater		X

Limited Exclusion: Trenching and resurfacing work associated with utility projects are not considered priority projects. Parking lots, buildings and other structures associated with utility projects are subject to SUSMP requirements if one or more of the criteria above are met.

If you answered **NO** to all the questions, then **STOP**. Please complete a Minor SWMP for your project.

If you answered **YES** to any of the questions, please continue.

The following questions provide a guide to collecting information relevant to project stormwater quality issues. Please provide a description of the findings in text box below.

	QUESTIONS	COMPLETED	NA
1.	Describe the topography of the project area.	X	
2.	Describe the local land use within the project area and adjacent areas.	X	
3.	Evaluate the presence of dry weather flow.	X	
4.	Determine the receiving waters that may be affected by the project throughout the project life cycle (i.e., construction, maintenance and operation).	X	
5.	For the project limits, list the 303(d) impaired receiving water bodies and their constituents of concern.	X	
6.	Determine if there are any High Risk Areas (municipal or domestic water supply reservoirs or groundwater percolation facilities) within the project limits.	X	
7.	Determine the Regional Board special requirements, including Total Maximum Daily Loads (TMDLs), effluent limits, etc.	X	
8.	Determine the general climate of the project area. Identify annual rainfall and rainfall intensity curves.	X	
9.	If considering Treatment BMPs, determine the soil classification, permeability, erodibility, and depth to groundwater.	X	
10.	Determine contaminated or hazardous soils within the project area.	X	

Please provide a description of the findings in the following box. For example:
The project is located in the San Diego Hydrologic unit. The area is characterized by rolling grassy hills and shrubs. Runoff from the project drains into a MS4 that eventually drains to Los Coches Creek. Within the project limit there are no 303(d) impaired receiving water and no Regional Board special requirements.

The proposed project site is currently comprised of terrain with approximately 50 percent of its slopes ranging from zero to 15 percent, 25 percent of its slopes ranging from 15 to 25 percent and 25 percent of its slopes ranging from 25 to 50 percent. The project site is lightly vegetated with trees and bushes and occasional rock outcroppings are present along the ground surface. This 0.82 net-acre parcel is currently vacant land, which was previously disturbed by sand mining operations. The proposed 3-parcel subdivision is bordered to the west by a residential subdivision (Map No. 13021, Tract 4866, Lots 4 through 10), to the south by another residential subdivision (Map No 6987), and to the southeast by undeveloped land, owned by the El Cajon Valley Company shown on Map No. 289. Also located to the west are Los Coches Road and the remainder of Lot 138 per Map No. 289.

No dry weather flow is present either traveling onto or at the site currently. During a rainfall event, however, runoff from the undeveloped site will typically accumulate and pond in a large depression located within the site that acts as a basin. Should any storm water leave the site it would enter the Los Coches Road right-of-way and travel northerly within curb and gutter for approximately 200 feet to Los Coches Court. Runoff flows then turns westerly and travels 200 feet down Los Coches Court to a curb inlet located there. Once runoff enters the storm drain system it is conveyed through a pipe culvert that ultimately discharges into Los Coches Flood Channel/Creek, a tributary to the San Diego River. The undeveloped land produces 0.73 cubic feet per second (cfs) and 1.06 cfs based upon a 10-year and 100-year storm frequency, respectively.

The Los Coches Flood Channel/Creek is located adjacent to the proposed subdivision and is the primary receiving water for the project site. Where the undeveloped site routes virtually no runoff to the Los Coches Road right-of-way prior to entering Los Coches Creek, the developed site will be graded such that a portion of the proposed runoff produced by a 0.11-acre area will enter Los Coches Flood Channel/Creek directly to the south. The diverted runoff flow is 0.24 cfs and 0.35 cfs based upon a 10-year and 100-year storm frequency, respectively. The remainder of proposed runoff (2.12 cfs and 1.45 cfs based upon a 10-year and 100-year storm frequency, respectively) will also be diverted offsite and follow the potential drainage pattern described previously for the undeveloped condition, ultimately discharging to Los Coches Flood Channel/Creek. Once runoff confluences with Los Coches Flood Channel/Creek flows it travels approximately 2 miles down the Los Coches Flood Channel/Creek to the San Diego River. From the San Diego River, storm water travels another approximately 23 miles and discharges to the Pacific Ocean. According to the California 2002 303(d) list published by the San Diego Regional Water Quality Control Board, the Pacific Ocean shoreline at the San Diego River is an impaired water body. The mouth of the San Diego River has approximately 3.7 miles of shoreline and river impaired by Coliform bacteria. The Total Maximum Daily Load (TMDL) priority for the mouth of the San Diego River is medium.

According to the United States Geologic Survey Map for the proposed site, there are no High Risk Areas, Municipal or domestic water supply reservoirs, or groundwater percolation facilities within the project limits. In addition, there are no San Diego Regional Water Quality Control Board special requirements for this area/project. The average annual rainfall for the area is between 15 and 20 inches. Based upon the County of San Diego Hydrology Manual's Isopluvial Maps, rainfall for a 10-year 6-hour and a 100-year 6-hour storm event are 1.85 inches and 2.7 inches, respectively. The soil type at the project site is Type B and the runoff coefficient, C, is 0.25 for the undeveloped site condition. The County of San Diego Hydrology Manual's Figure 3-1, Intensity-Duration Design Chart, was used as the basis for determining runoff flows for this project. The soil erodibility is 0.17 for coarse sandy loam, which is predominantly present at the project site. Ground water levels in the area are estimated to be between 10 and 15 feet below existing ground surface. The title report for the proposed site does not indicate that contaminated or hazardous soils are present within the project area.

Complete the checklist below to determine if Treatment Best Management Practices (BMPs) are required for the project.

No.	CRITERIA	YES	NO	INFORMATION
1.	Is this an emergency project		X	If YES, go to 6. If NO, continue to 2.
2.	Have TMDLs been established for surface waters within the project limit?		X	If YES, go to 5. If NO, continue to 3.
3.	Will the project directly discharge to a 303(d) impaired receiving water body?		X	If YES, go to 5. If NO, continue to 4.
4.	Is this project within the urban and environmentally sensitive areas as defined on the maps in Appendix B of the *County of San Diego Standard Urban Storm Water Mitigation Plan for Land Development and Public Improvement Projects*?	X		If YES, continue to 5. If NO, go to 6.
5.	Consider approved Treatment BMPs for the project.	X		If YES, go to 7.
6.	Project is not required to consider Treatment BMPs			Document for Project Files by referencing this checklist.
7.	End	X		

Now that the need for a treatment BMPs has been determined, other information is needed to complete the SWMP.

WATERSHED

Please check the watershed(s) for the project.

☐ San Juan	☐ Santa Margarita	☐ San Luis Ray	☐ Carlsbad
☐ San Dieguito	☐ Penasquitos	☒ San Diego	☐ Pueblo San Diego
☐ Sweetwater	☐ Otay	☐ Tijuana	

Please provide the hydrologic sub-area and number(s)

Number	Name
907.14	**COCHES HAS**

Please provide the beneficial uses for Inland Surface Waters and Ground Waters. Beneficial Uses can be obtained from the Water Quality Control Plan For The San Diego Basin, which is available at the Regional Board office or at http://www.swrcb.ca.gov/rwqcb9/programs/basinplan.html.

SURFACE WATERS	Hydrologic Unit Basin Number	MUN	AGR	IND	PROC	GWR	FRESH	POW	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN
Inland Surface Waters	**907.14**	*	X	X					X	X		X		X		
Ground Waters	**907.14**	X	X	X												

X Existing Beneficial Use
0 Potential Beneficial Use
* Excepted from Municipal

POLLUTANTS OF CONCERN

Using Table 1, identify pollutants that are anticipated to be generated from the proposed priority project categories. Pollutants associated with any hazardous material sites that have been remediated or are not threatened by the proposed project are not considered a pollutant of concern.

Table 1. Anticipated and Potential Pollutants Generated by Land Use Type

	General Pollutant Categories								
Priority Project Categories	Sediments	Nutrients	Heavy Metals	Organic Compounds	Trash & Debris	Oxygen Demanding Substances	Oil & Grease	Bacteria & Viruses	Pesticides
Detached Residential Development	X	X			X	X	X	X	X
Attached Residential Development	X	X			X	P(1)	P(2)	P	X
Commercial Development >100,000 ft²	P(1)	P(1)		P(2)	X	P(5)	X	P(3)	P(5)
Automotive Repair Shops			X	X(4)(5)	X		X		
Restaurants					X	X	X	X	
Hillside Development >5,000 ft²	X	X			X	X	X		X
Parking Lots	P(1)	P(1)	X		X	P(1)	X		P(1)
Streets, Highways & Freeways	X	P(1)	X	X(4)	X	P(5)	X		

X = anticipated
P = potential
(1) A potential pollutant if landscaping exists on-site.
(2) A potential pollutant if the project includes uncovered parking areas.
(3) A potential pollutant if land use involves food or animal waste products.
(4) Including petroleum hydrocarbons.
(5) Including solvents.

Note: If other monitoring data that is relevant to the project is available. Please include as Attachment C.

CONSTRUCTION BMPs

Please check the construction BMPs that may be used. The BMPs selected are those that will be implemented during construction of the project. The applicant is responsible for the placement and maintenance of the BMPs selected.

☒ Silt Fence	☐ Desilting Basin
☒ Fiber Rolls	☒ Gravel Bag Berm
☒ Street Sweeping and Vacuuming	☐ Sandbag Barrier
☒ Storm Drain Inlet Protection	☒ Material Delivery and Storage
☒ Stockpile Management	☒ Spill Prevention and Control
☒ Solid Waste Management	☒ Concrete Waste Management
☒ Stabilized Construction Entrance/Exit	☒ Water Conservation Practices
☐ Dewatering Operations	☒ Paving and Grinding Operations
☐ Vehicle and Equipment Maintenance	
☒ Any minor slopes created incidental to construction and not subject to a major or minor grading permit shall be protected by covering with plastic or tarp prior to a rain event, and shall have vegetative cover reestablished within 180 days of completion of the slope and prior to final building approval.	

SITE DESIGN

To minimize stormwater impacts, site design measures must be addressed. The following checklist provides options for avoiding or reducing potential impacts during project planning. If YES is checked, it is assumed that the measure was used for this project. If NO is checked, please provide a brief explanation why the option was not selected in the text box below.

		OPTIONS	YES	NO	N/A
1.	Can the project be relocated or realigned to avoid/reduce impacts to receiving waters or to increase the preservation of critical (or problematic) areas such as floodplains, steep slopes, wetlands, and areas with erosive or unstable soil conditions?			X	
2.	Can the project be designed to minimize impervious footprint?		X		
3.	Conserve natural areas where feasible?		X		
4.	Where landscape is proposed, can rooftops, impervious sidewalks, walkways, trails and patios be drained into adjacent landscaping?		X		
5.	For roadway projects, can structures and bridges be designed or located to reduce work in live streams and minimize construction impacts?				X
6.	Can any of the following methods be utilized to minimize erosion from slopes:				
	6.a.	Disturbing existing slopes only when necessary?	X		
	6.b.	Minimize cut and fill areas to reduce slope lengths?	X		
	6.c.	Incorporating retaining walls to reduce steepness of slopes or to shorten slopes?	X		
	6.d.	Providing benches or terraces on high cut and fill slopes to reduce concentration of flows?		X	
	6.e.	Rounding and shaping slopes to reduce concentrated flow?	X		
	6.f.	Collecting concentrated flows in stabilized drains and channels?	X		

Please provide a brief explanation for each option that was checked N/A or NO in the following box.

1. Project location cannot be relocated as the Owner purchased this undeveloped land from the County of San Diego for the purpose of development.
5. No roadway improvements are proposed for this project.
6. Benches and terraces were not practical since few fill slopes are proposed in the preliminary grading plan and incorporation of retaining walls into site design meet this objective.

If the project includes work in channels, then complete the following checklist. Information shall be obtained from the project drainage report. **NO WORK IS PROPOSED IN A CHANNEL.**

No.	CRITERIA	YES	NO	N/A	COMMENTS
1.	Will the project increase velocity or volume of downstream flow?				If YES go to 5.
2.	Will the project discharge to unlined channels?				If YES go to 5.
3.	Will the project increase potential sediment load of downstream flow?				If YES go to 5.
4.	Will the project encroach, cross, realign, or cause other hydraulic changes to a stream that may affect downstream channel stability?				If YES go to 7.
5.	Review channel lining materials and design for stream bank erosion.				Continue to 6.
6.	Consider channel erosion control measures within the project limits as well as downstream. Consider scour velocity.				Continue to 7.
7.	Include, where appropriate, energy dissipation devices at culverts.				Continue to 8.
8.	Ensure all transitions between culvert outlets/headwalls/wingwalls and channels are smooth to reduce turbulence and scour.				Continue to 9.
9.	Include, if appropriate, detention facilities to reduce peak discharges.				
10.	"Hardening" natural downstream areas to prevent erosion is not an acceptable technique for protecting channel slopes, unless pre-development conditions are determined to be so erosive that hardening would be required even in the absence of the proposed development.				Continue to 11.
11.	Provide other design principles that are comparable and equally effective.				Continue to 12.
12.	End				

SOURCE CONTROL

Please complete the following checklist for Source Control BMPs. If the BMP is not applicable for this project, then check N/A only at the main category.

BMP			YES	NO	N/A
1.	**Provide Storm Drain System Stenciling and Signage**				X
	1.a.	All storm drain inlets and catch basins within the project area shall have a stencil or tile placed with prohibitive language (such as: "NO DUMPING – DRAINS TO ________") and/or graphical icons to discourage illegal dumping.			
	1.b.	Signs and prohibitive language and/or graphical icons, which prohibit illegal dumping, must be posted at public access points along channels and creeks within the project area.			
2.	**Design Outdoors Material Storage Areas to Reduce Pollution Introduction**				
	2.a.	This is a detached single-family residential project. Therefore, personal storage areas are exempt from this requirement.	X		
	2.b.	Hazardous materials with the potential to contaminate urban runoff shall either be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the storm water conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.			X
	2.c.	The storage area shall be paved and sufficiently impervious to contain leaks and spills.			X
	2.d.	The storage area shall have a roof or awning to minimize direct precipitation within the secondary containment area.			X
3.	**Design Trash Storage Areas to Reduce Pollution Introduction**				
	3.a.	Paved with an impervious surface, designed not to allow run-on from adjoining areas, screened or walled to prevent off-site transport of trash; or,	X		
	3.b.	Provide attached lids on all trash containers that exclude rain, or roof or awning to minimize direct precipitation.	X		
4.	**Use Efficient Irrigation Systems & Landscape Design**				
	The following methods to reduce excessive irrigation runoff shall be considered, and incorporated and implemented where determined applicable and feasible.				
	4.a.	Employing rain shutoff devices to prevent irrigation after precipitation.	X		
	4.b.	Designing irrigation systems to each landscape area's specific water requirements.	X		
	4.c.	Using flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.	X		
	4.d.	Employing other comparable, equally effective, methods to reduce irrigation water runoff.	X		
5.	**Private Roads**				X
	The design of private roadway drainage shall use at least one of the following				
	5.a.	Rural swale system: street sheet flows to vegetated swale or gravel shoulder, curbs at street corners, culverts under driveways and street crossings.			
	5.b.	Urban curb/swale system: street slopes to curb, periodic swale inlets drain to vegetated swale/biofilter.			

	5.c.	Dual drainage system: First flush captured in street catch basins and discharged to adjacent vegetated swale or gravel shoulder, high flows connect directly to storm water conveyance system.			
	5.d.	Other methods that are comparable and equally effective within the project.			
6.	**Residential Driveways & Guest Parking**				
	The design of driveways and private residential parking areas shall use one at least of the following features.				
	6.a.	Design driveways with shared access, flared (single lane at street) or wheelstrips (paving only under tires); or, drain into landscaping prior to discharging to the storm water conveyance system.		X	
	6.b.	Uncovered temporary or guest parking on private residential lots may be: paved with a permeable surface; or, designed to drain into landscaping prior to discharging to the storm water conveyance system.	X		
	6.c.	Other features which are comparable and equally effective.		X	
7.	**Dock Areas**				X
	Loading/unloading dock areas shall include the following.				
	7.a.	Cover loading dock areas, or design drainage to preclude urban run-on and runoff.			
	7.b.	Direct connections to storm drains from depressed loading docks (truck wells) are prohibited.			
	7.c.	Other features which are comparable and equally effective.			
8.	**Maintenance Bays**				X
	Maintenance bays shall include the following.				
	8.a.	Repair/maintenance bays shall be indoors; or, designed to preclude urban run-on and runoff.			
	8.b.	Design a repair/maintenance bay drainage system to capture all wash water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.			
	8.c.	Other features which are comparable and equally effective.			
9.	**Vehicle Wash Areas**				X
	Priority projects that include areas for washing/steam cleaning of vehicles shall use the following.				
	9.a.	Self-contained; or covered with a roof or overhang.			
	9.b.	Equipped with a clarifier or other pretreatment facility.			
	9.c.	Properly connected to a sanitary sewer.			
	9.d.	Other features which are comparable and equally effective.			
10.	**Outdoor Processing Areas**				X
	Outdoor process equipment operations, such as rock grinding or crushing, painting or coating, grinding or sanding, degreasing or parts cleaning, waste piles, and wastewater and solid waste treatment and disposal, and other operations determined to be a potential threat to water quality by the County shall adhere to the following requirements.				
	10.a.	Cover or enclose areas that would be the most significant source of pollutants; or, slope the area toward a dead-end sump; or, discharge to the sanitary sewer system following appropriate treatment in accordance with conditions established by the applicable sewer agency.			
	10.b.	Grade or berm area to prevent run-on from surrounding areas.			
	10.c.	Installation of storm drains in areas of equipment repair is prohibited.			
	10.d.	Other features which are comparable or equally effective.			
11.	**Equipment Wash Areas**				X
	Outdoor equipment/accessory washing and steam cleaning activities shall be.				
	11.a.	Be self-contained; or covered with a roof or overhang.			

	11.b.	Be equipped with a clarifier, grease trap or other pretreatment facility, as appropriate			
	11.c.	Be properly connected to a sanitary sewer.			
	11.d.	Other features which are comparable or equally effective.			
12.	**Parking Areas**				X
	The following design concepts shall be considered, and incorporated and implemented where determined applicable and feasible by the County.				
	12.a.	Where landscaping is proposed in parking areas, incorporate landscape areas into the drainage design.			
	12.b.	Overflow parking (parking stalls provided in excess of the County's minimum parking requirements) may be constructed with permeable paving.			
	12.c.	Other design concepts that are comparable and equally effective.			
13.	**Fueling Area**				X
	Non-retail fuel dispensing areas shall contain the following.				
	13.a.	Overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area. The fueling area shall drain to the project's treatment control BMP(s) prior to discharging to the storm water conveyance system.			
	13.b.	Paved with Portland cement concrete (or equivalent smooth impervious surface). The use of asphalt concrete shall be prohibited.			
	13.c.	Have an appropriate slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of urban runoff.			
	13.d.	At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.			

Please list other project specific Source Control BMPs in the following box. Write **N/A** if there are none and briefly explain.

Household chemicals, trash cans and other potential sources of contamination are contained within the attached garage or residential home. The current site has an erosion problem. The erosion has been reduced through the proposed site design of grass-lined swales. Pervious Pavement will be used on driveways to reduce runoff volumes while providing treatment.

TREATMENT CONTROL

To select a structural treatment BMP using Treatment Control BMP Selection Matrix (Table 2), each priority project shall compare the list of pollutants for which the downstream receiving waters are impaired (if any), with the pollutants anticipated to be generated by the project (as identified in Table 1). Any pollutants identified by Table 1, which are also causing a Clean Water Act section 303(d) impairment of the receiving waters of the project, shall be considered primary pollutants of concern. Priority projects that are anticipated to generate a primary pollutant of concern shall select a single or combination of stormwater BMPs from Table 2, which **maximizes pollutant removal** for the particular primary pollutant(s) of concern.

Priority projects that are **not** anticipated to generate a pollutant for which the receiving water is Clean Water Act Section 303(d) impaired shall select a single or combination of stormwater BMPs from Table 2, which are effective for pollutant removal of the identified secondary pollutants of concern, consistent with the "maximum extent practicable" standard.

Table 2. Treatment Control BMP Selection Matrix

Pollutant of Concern	*Treatment Control BMP Categories*						
	Biofilters	Detention Basins	Infiltration Basins(2)	Wet Ponds or Wetlands	Drainage Inserts	Filtration	Hydrodynamic Separator Systems(3)
Sediment	M	H	H	H	L	H	M
Nutrients	L	M	M	M	L	M	L
Heavy Metals	M	M	M	H	L	H	L
Organic Compounds	U	U	U	M	L	M	L
Trash & Debris	L	H	U	H	M	H	M
Oxygen Demanding Substances	L	M	M	M	L	M	L
Bacteria	U	U	H	H	L	M	L
Oil & Grease	M	M	U	U	L	H	L
Pesticides	U	U	U	L	L	U	L

(1) Copermittees are encouraged to periodically assess the performance characteristics of many of these BMPs to update this table.
(2) Including trenches and porous pavement.
(3) Also known as hydrodynamic devices and baffle boxes.

L: Low removal efficiency):
M: Medium removal efficiency):
H: High removal efficiency):
U: Unknown removal efficiency

Sources: *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (1993), *National Stormwater Best Management Practices Database* (2001), *Guide for BMP Selection in Urban Developed Areas* (2001), *and Caltrans New Technology Report (2001).*

A Treatment BMP must address runoff from developed areas. Please provide the post-construction water quality values for the project. Label outfalls on the BMP map. Q_{WQ} is dependent on the type of treatment BMP selected for the project.

Outfall	**Tributary Area (acres)**	**Q_{100} (cfs)**	**Q_{WQ} (cfs)**
A	0.70	1.07	0.081
B	0.11	0.32	0.011

* See Attachment E for Q_{100} and Q_{WQ} runoff calculations.

Please check the box(s) that best describes the Treatment BMP(s) selected for this project.

Biofilters

☒ Grass swale
☐ Grass strip
☐ Wetland vegetation swale
☐ Bioretention

Detention Basins

☐ Extended/dry detention basin with grass lining
☐ Extended/dry detention basin with impervious lining

Infiltration Basins

☐ Infiltration basin
☐ Infiltration trench
☒ Porous asphalt
☒ Porous concrete
☐ Porous modular concrete block

Wet Ponds or Wetlands

☐ Wet pond/basin (permanent pool)
☐ Constructed wetland

Drainage Inserts (See note below)

☐ Oil/Water separator
☐ Catch basin insert
☐ Storm drain inserts
☐ Catch basin screens

Filtration

☐ Media filtration
☐ Sand filtration

Hydrodynamic Separator Systems

☐ Swirl Concentrator
☐ Cyclone Separator
☐ Baffle Separator
☐ Gross Solids Removal Device
☐ Linear Radial Device

Note: Catch basin inserts and storm drain inserts are excluded from use on County maintained right-of-way and easements.

Include Treatment Datasheet as Attachment E. The datasheet should include the following:	**COMPLETED**	**NO**
1. Description of how treatment BMP was designed. Provide a description for each type of treatment BMP.	**X**	
2. Engineering calculations for the BMP(s)	**X**	

Please describe why the selected treatment BMP(s) was selected for this project. For projects utilizing a low performing BMP, please provide a detailed explanation and justification.

No primary pollutant of concern exists for this project based upon the current 303(d) list published by the Regional Water Quality Control Board for downstream water quality impairments. Bacteria and viruses, oxygen demanding substances and oil and grease are identified only as potential pollutants generated by attached residential developments. Other pollutants (anticipated) generated by attached residential developments include sediment, nutrients, trash, debris and pesticides. Thus, as no anticipated pollutants coincide with 303(d) listed impairments, no primary pollutants of concern are anticipated for this project. The only BMP's listed that have known effective removal efficiency for bacteria are Wet Ponds, Infiltration Basins, Drainage Inserts, Filtration and Hydrodynamic Separators. In consideration of the aforementioned BMP's to be incorporated as treatment control BMP's for the Los Coches subdivision project each was evaluated. Wet Ponds and Infiltration Basins are classified to have high removal efficiencies for bacteria; however these BMP's are not suitable for this development. For example, Wet Ponds are typically used for drainage basins more than 10 acres and since the entire site's drainage basin is only 0.82 acres, this treatment option is not practical or feasible. Infiltration Basins require undisturbed ground, adequate head to ensure operational flow through splitter structure and over three (9) feet of separation to groundwater. These design parameters are not feasible at the proposed site, therefore, cannot be reasonably incorporated into the design. Filtration and Hydrodynamic Separators provides medium and low removal efficiency for bacteria and viruses, respectively. These proprietary devices typically require adequate elevation difference between the inlet and outlet to operate effectively. In addition, they are designed to discharge directly into a closed drainage system. Neither of these conditions can be met at the proposed site. The remaining treatment control Best Management Practices (BMPs) provide low or unknown removal efficiencies for bacteria, the primary pollutant of concern.

Detention Basins and Biofilters have unknown removal efficiencies for bacteria, pesticides, and oxygen demanding substances, however, they are known to remove sediment, trash, debris, grease, and oil with medium to high efficiencies. It is not practical to incorporate detention basins into each separate parcel, therefore, one location was considered. However, since the maintenance of a single detention basin that would receive storm water runoff from adjacent parcels would be default exclusively to that property owner, this is considered and unfair burden.

Grass lined swales are the most practical means of storm water treatment for the proposed project. Grass lined swales are designed as both a drainage conveyance system and treatment control BMP at the Los Coches site. They have been designed with a capacity to convey runoff produced a 100-year storm event. Grass-lined swales have been designed and implemented throughout the proposed project and can be seen illustrated in Attachment D, Treatment BMP Location Map. Dimension and locations for grass lined swales can be found in Attachment D, Treatment BMP Location Map.

LOW IMPACT DEVELOPMENT (LID)

Each numbered item below is a LID requirement of the WPO. Please check the box(s) under each number that best describes the Low Impact Development BMP(s) selected for this project.

Table 8

1. Conserve natural Areas, Soils, and Vegetation-County LID Handbook 2.2.1
☐ Preserve well draining soils (Type A or B)
☐ Preserve Significant Trees
☐ Other. Description:
☑ 1. Not feasible. State Reason: EXISTING SITE PREVIOUSLY DISTURBED AS WAS HISTORICALLY MINED FOR AGGREGATES.
2. Minimize Disturbance to Natural Drainages-County LID Handbook 2.2.2
☐ Set-back development envelope from drainages
Restrict heavy construction equipment access to planned green/open space areas
☐ Other. Description:
☑ 2. Not feasible. State Reason: EXISTING TOPOGRAPHY IS A DEPRESSION AS WAS HISTORICALLY MINED FOR AGGREGATES.
3. Minimize and Disconnect Impervious Surfaces (see 5) -County LID Handbook 2.2.3
☐ Clustered Lot Design
☑ Items checked in 5?
☐ Other. Description:
☐ 3. Not feasible. State Reason:
4. Minimize Soil Compaction-County LID Handbook 2.2.4
Restrict heavy construction equipment access to planned green/open space areas
☐ Re-till soils compacted by construction vehicles/equipment
Collect & re-use upper soil layers of development site containing organic materials
☐ Other. Description:
4. Not feasible. State Reason: MAJORITY OF SITE WILL BE RAISED WITH EMBANKMENT FILL - SEE SITE SECTION VIEWS.
5. Drain Runoff from Impervious Surfaces to Pervious Areas-County LID Handbook 2.2.5

LID Street & Road Design	
☐	Curb-cuts to landscaping
☐	Rural Swales
☐	Concave Median
☐	Cul-de-sac Landscaping Design
☐	Other. Description: N/A
LID Parking Lot Design	
☐	Permeable Pavements
☐	Curb-cuts to landscaping
☐	Other. Description: N/A
LID Driveway, Sidewalk, Bike-path Design	
☐	Permeable Pavements
☒	Pitch pavements toward landscaping
☐	Other. Description:
LID Building Design	
☐	Cisterns & Rain Barrels
☒	Downspout to swale
☐	Vegetated Roofs
☐	Other. Description:
LID Landscaping Design	
☐	Soil Amendments
☐	Reuse of Native Soils
☒	Smart Irrigation Systems
☐	Street Trees
☐	Other. Description:
☐ 5. Not feasible. State Reason:	

MAINTENANCE

Please check the box that best describes the maintenance mechanism(s) for this project.

CATEGORY	SELECTED	
	YES	NO
First		X
Second	X	
Third		X
Fourth		X

Please briefly describe the long-term fiscal resources for the selected maintenance mechanism(s).

Grass lined swales are one of the most cost and time effective means of ensuring storm water quality. Each homeowner will have the responsibility to maintain the bio-swales presented in this Plan. Specific maintenance for this treatment control BMP includes mowing 3 to 4 times yearly, to maintaining the prescribed 6-inch grass height, and removal of trash and debris 3 to 4 times yearly. See Attachment F, "Operation and Maintenance Program for Treatment BMP's", for additional information regarding Maintenance of aforementioned BMP's.

ATTACHMENTS

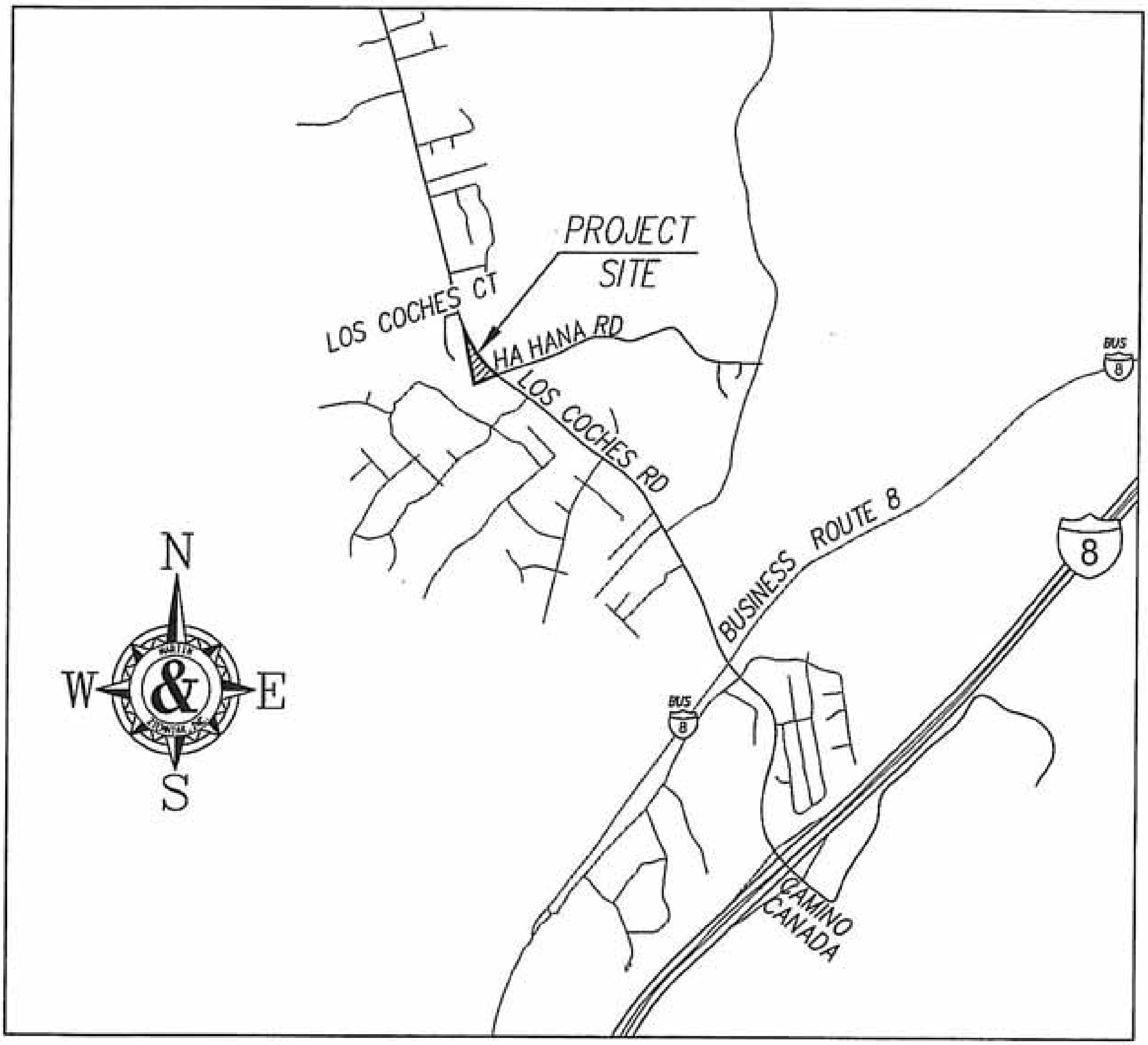
Please include the following attachments.

ATTACHMENT		COMPLETED	N/A
A	Project Location Map	X	
B	Site Map	X	
C	Relevant Monitoring Data		X
D	Treatment BMP Location Map	X	
E	Treatment BMP Datasheets	X	
F	Operation and Maintenance Program for Treatment BMPs	X	
G	Engineer's Certification Sheet	X	

Note: Attachments A and B may be combined.

ATTACHMENT A

LOCATION MAP

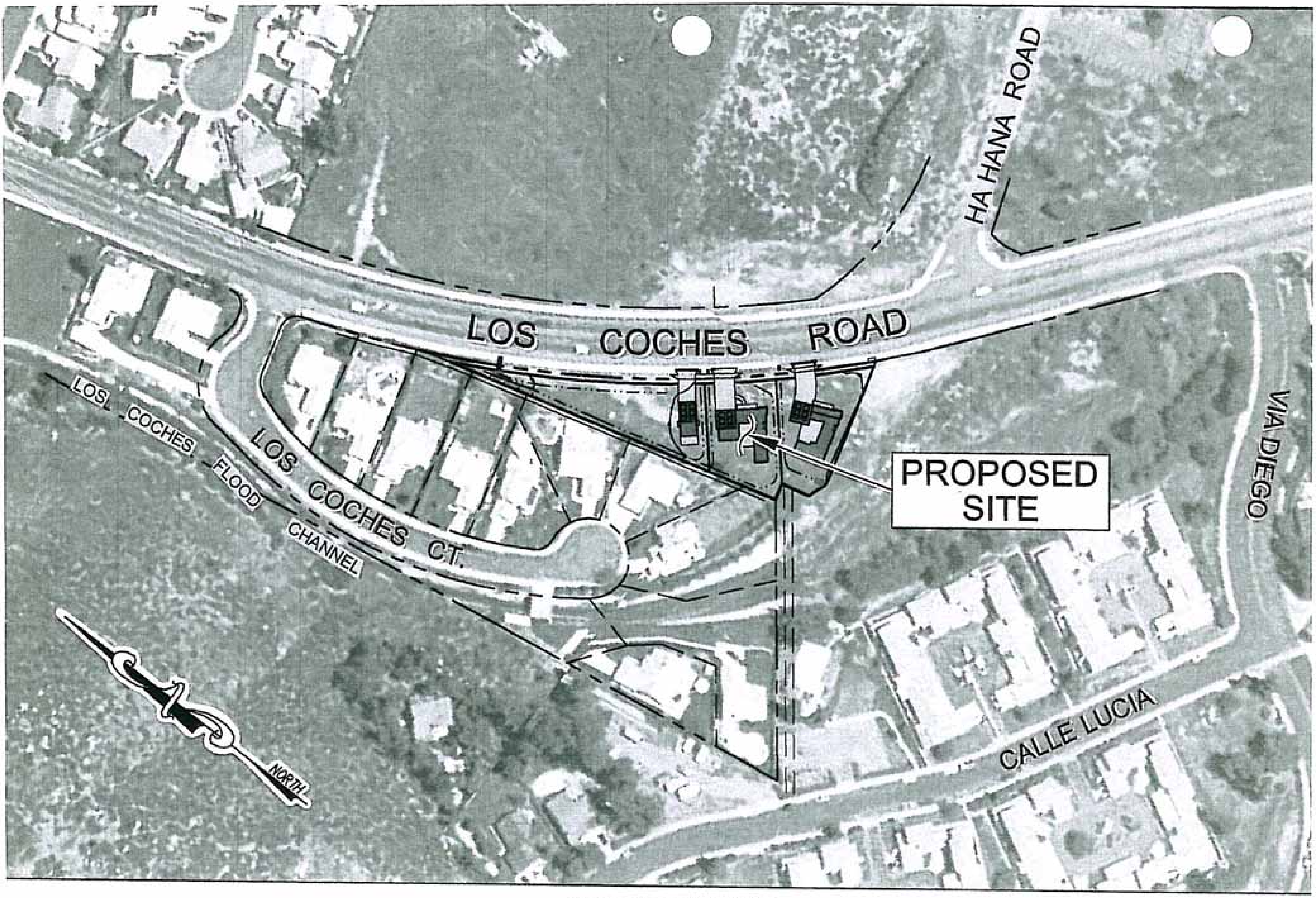


VICINITY MAP

NTS

ATTACHMENT B

PROJECT SITE MAP


HA HANA ROAD
LOS COCHES ROAD
VIA DIEGO
PROPOSED SITE
LOS COCHES CT.
LOS COCHES FLOOD CHANNEL
CALLE LUCIA
NORTH

SITE MAP

NTS

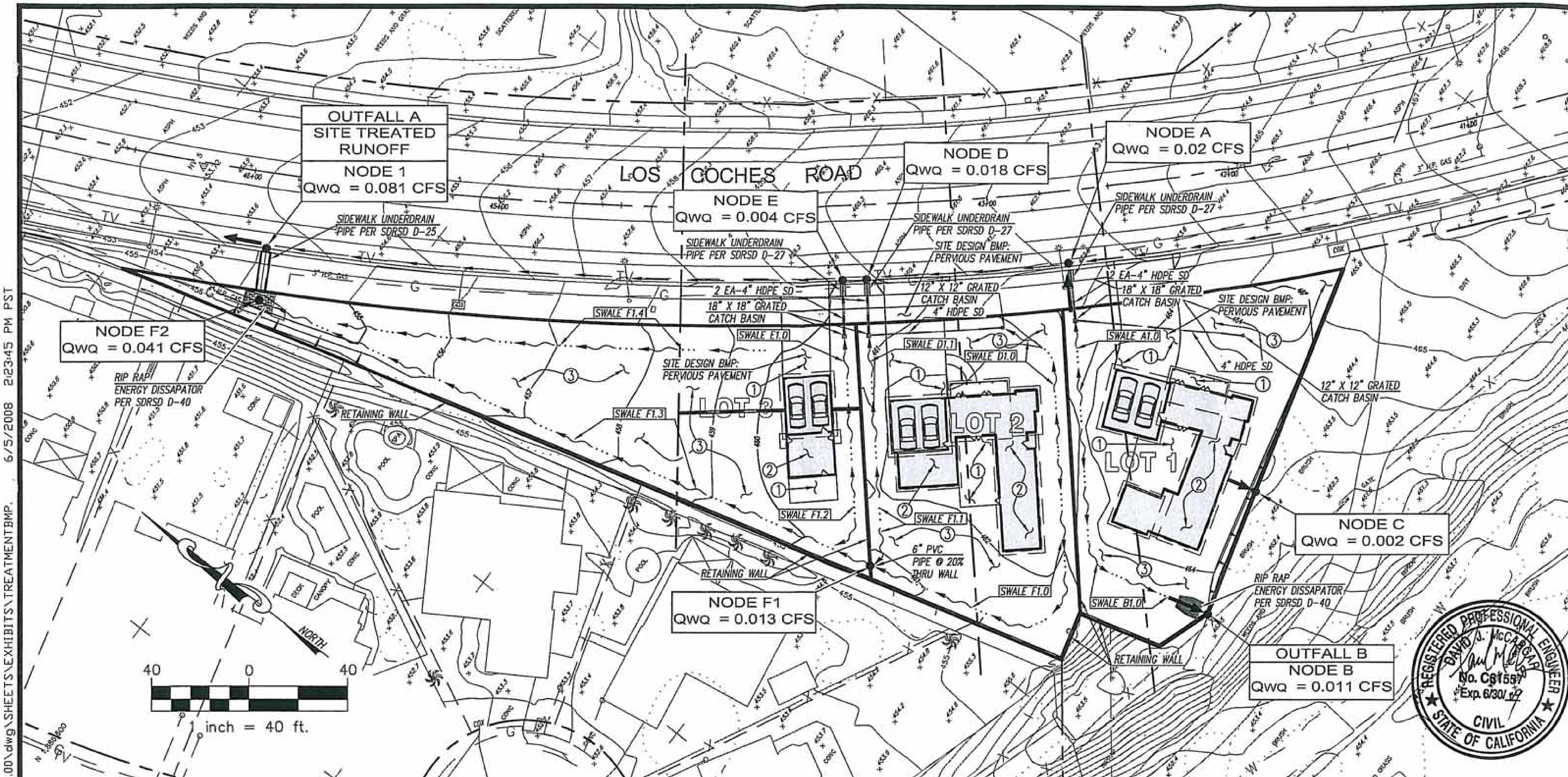
ATTACHMENT C

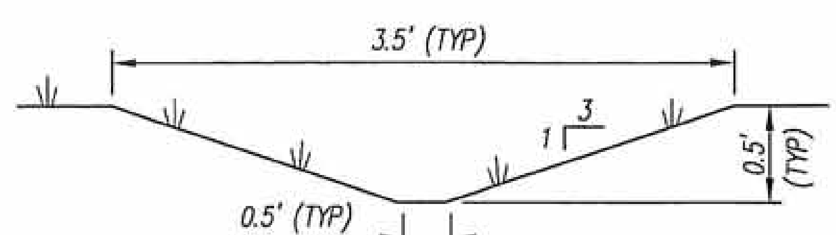
RELEVANT MONITORING DATA

(NOTE: PROVIDE RELEVANT WATER QUALITY MONITORING DATA IF AVAILABLE.)

ATTACHMENT D

LID AND TREATMENT BMP LOCATION MAP





TYPICAL BIO SWALE SECTION

SCALE: 1" = 4'

LEGEND

·····⁓→	TREATMENT BMP VEGETATED SWALE
——→	CONCENTRATED RUNOFF FLOW
➡	TRIBUTARY AREA STORM WATER QUALITY RUNOFF DISCHARGE

LOW IMPACT DEVELOPMENT (LID)

1. LID DRIVEWAY, SIDEWALKS, BIKE PATH DESIGN -PITCH PAVEMENTS TOWARD LANDSCAPING
2. LID BUILDING DESIGN -DOWNSPOUT TO SWALE
3. LID LANDSCAPE DESIGN -SMART IRRIGATION SYSTEMS

ATTACHMENT 'D'

PRIVATE CONTRACT

ANGEL ANTONIO TPM 21030
LOS COCHES ROAD
LID AND TREATMENT BMP LOCATION MAP

SCALE: 1" = 40'   SHEET 1 OF 1

Z:\Civil\Lar Projects 5\205114.00\dwg\SHEETS\EXHIBITS\TREATMENTBMP. 6/5/2008 2:23:45 PM PST

ATTACHMENT E

TREATMENT BMP DATASHEET

(**NOTE:** POSSIBLE SOURCE FOR DATASHEETS CAN BE FOUND AT WWW.CABMPHANDBOOKS.COM. INCLUDE ENGINEERING CALCULATIONS FOR SIZING THE TREATMENT BMP.)

LOS COCI. ;PM 21030
PROPOSED STORM WATER QUALITY CALCULATIONS

STORM WATER QUALITY CALCULATIONS

AREA NUMBER	AREA (ACRES)	COMBINED FINAL WEIGHTED C FOR AREA	Q_{WQ} STORM INTENSITY (0.2 INCH / HR)	Q_{WQ} =CIA STORM RUNOFF (CFS)
A 1.0	0.0742	0.56	0.20	0.008
A 1.1	0.0432	0.95	0.20	0.008
A 1.2	0.0279	0.45	0.20	0.003
B 1.0	0.0256	0.95	0.20	0.005
B 1.1	0.0695	0.45	0.20	0.006
C 1.0	0.0209	0.45	0.20	0.002
D 1.0	0.0187	0.95	0.20	0.004
D 1.1	0.0457	0.50	0.20	0.005
D 1.2	0.0387	0.95	0.20	0.007
D 1.3	0.0186	0.45	0.20	0.002
E 1.0	0.0122	0.95	0.20	0.002
E 1.1	0.0182	0.45	0.20	0.002
F 1.0	0.0224	0.95	0.20	0.004
F 1.1	0.0965	0.45	0.20	0.009
F 1.2	0.2674	0.45	0.20	0.024
F 1.3	0.0213	0.95	0.20	0.004
TOTAL ON SITE STORM WATER RUNOFF				0.094

LOS COCI. ;PM 21030
PROPOSED CONDITION HYDROLOGY CALCULATIONS

TABLE B7 -RAINFALL INTENSITY AND RUNOFF Q IN CFS

AREA	COMBINED FINAL WEIGHTED C FOR AREA INCONSIDERATION	AREA (ACRES)	MINIMUM TIME $T_c=T_i+T_t$ (Minutes)	10-YEAR STORM INTENSITY FIGURE 3-1 (INCH/HR)	100-YEAR STORM INTENSITY FIGURE 3-1 (INCH/HR)	Q=CIA 10-YEAR PEAK STORM RUNOFF (CFS)	Q=CIA 100-YEAR PEAK STORM RUNOFF (CFS)
A 1.0	0.56	0.0742	9.07	3.32	4.84	0.14	0.20
A 1.1	0.95	0.0432	5.00	4.87	7.11	0.20	0.29
A 1.2	0.45	0.0279	5.00	4.87	7.11	0.06	0.09
B 1.0	0.95	0.0256	5.38	4.65	6.78	0.11	0.16
B 1.1	0.45	0.0695	8.46	3.47	5.07	0.11	0.16
C 1.0	0.45	0.0209	5.00	4.87	7.11	0.05	0.07
D 1.0	0.95	0.0187	5.86	4.40	6.42	0.08	0.11
D 1.1	0.50	0.0457	9.05	3.32	4.85	0.08	0.11
D 1.2	0.95	0.0387	5.00	4.87	7.11	0.18	0.26
D 1.3	0.45	0.0186	5.00	4.87	7.11	0.04	0.06
E 1.0	0.95	0.0122	5.48	4.60	6.71	0.05	0.08
E 1.1	0.45	0.0182	7.37	3.80	5.54	0.03	0.05
F 1.0	0.95	0.0224	6.64	4.06	5.93	0.09	0.13
F 1.1	0.45	0.0965	13.39	2.58	3.77	0.11	0.16
F 1.2	0.45	0.2674	10.85	2.96	4.32	0.36	0.52
F 1.3	0.95	0.0213	6.36	4.17	6.09	0.08	0.12
TOTAL ON-SITE STORM WATER RUNOFF						1.00	1.46

TABLE B1 - C FACTOR TABLE

DRAINAGE AREA (ACRES)	PERVIOUS AREA IN ACRES (C=0.45)	IMPERVIOUS AREA IN ACRES (C = 0.95)	WEIGHTED C PERVIOUS	WEIGHTED C IMPERVIOUS	COMBINED FINAL WEIGHTED C FOR AREA
A 1.0 = 0.0742 AC	0.0582	0.0160	0.35	0.20	0.56
A 1.1 = 0.0432 AC	0.0000	0.0432	0.00	0.95	0.95
A 1.2 = 0.0279 AC	0.0279	0.0000	0.45	0.00	0.45
B 1.0 = 0.0256 AC	0.0000	0.0256	0.00	0.95	0.95
B 1.1 = 0.0695 AC	0.0695	0.0000	0.45	0.00	0.45
C 1.0 = 0.0209 AC	0.0209	0.0000	0.45	0.00	0.45
D 1.0 = 0.0187 AC	0.0000	0.0187	0.00	0.95	0.95
D 1.1 = 0.0457 AC	0.0414	0.0043	0.41	0.09	0.50
D 1.2 = 0.0387 AC	0.0000	0.0387	0.00	0.95	0.95
D 1.3 = 0.0186 AC	0.0186	0.0000	0.45	0.00	0.45
E 1.0 = 0.0122 AC	0.0000	0.0122	0.00	0.95	0.95
E 1.1 = 0.0182 AC	0.0182	0.0000	0.45	0.00	0.45
F 1.0 = 0.0224 AC	0.0000	0.0224	0.00	0.95	0.95
F 1.1 = 0.0965 AC	0.0965	0.0000	0.45	0.00	0.45
F 1.2 = 0.2674 AC	0.2671	0.0000	0.45	0.00	0.45
F 1.3 = 0.0213 AC	0.0000	0.0213	0.00	0.95	0.95

TABLE B2 - SLOPE AND DISTANCE FACTOR TABLE FOR INITIAL TIME OF CONCENTRATION [T_i]

DRAINAGE AREA (ACRES)	HIGH UPSTREAM ELEVATION (FEET)	LOW DOWN STREAM ELEVATION (FEET)	VERTICAL HEIGHT DIFFERENCE (FEET)	DISTANCE TRAVELED (FEET)	SLOPE AVERAGE (PERCENT)
A 1.0 = 0.0742 AC	465.72	463.71	2.0	50.0	4.02
A 1.1 = 0.0432 AC	464.03	463.01	1.0	42.0	2.43
A 1.2 = 0.0279 AC	463.92	463.01	0.9	43.0	2.12
B 1.0 = 0.0256 AC	0.96	0.00	1.0	48.0	2.00
B 1.1 = 0.0695 AC	463.92	463.00	0.9	100.0	0.92
C 1.0 = 0.0209 AC	0.20	0.00	0.2	10.0	2.00
D 1.0 = 0.0187 AC	0.60	0.00	0.6	30.0	2.00
D 1.1 = 0.0457 AC	462.46	461.80	0.7	60.0	1.10
D 1.2 = 0.0387 AC	462.28	460.61	1.7	72.0	2.32
D 1.3 = 0.0166 AC	461.95	460.61	1.3	63.0	2.13
E 1.0 = 0.0122 AC	0.88	0	0.9	44.0	2.00
E 1.1 = 0.0182 AC	460.73	460.27	0.5	65.0	0.71
F 1.0 = 0.0224 AC	462.33	462.01	0.3	33.0	0.97
F 1.1 = 0.0965 AC	462.46	460.72	1.7	150.0	1.16
F 1.2 = 0.2674 AC	460.73	453.7	7.0	275.0	2.56
F 1.3 = 0.0213 AC	460.47	459.53	0.9	28.0	3.36

TABLE B3 - SLOPE AND DISTANCE FACTOR TABLE FOR TIME OF TRAVEL [T_t]

DRAINAGE AREA (ACRES)	HIGH UPSTREAM ELEVATION (FEET)	LOW DOWN STREAM ELEVATION (FEET)	VERTICAL HEIGHT DIFFERENCE (FEET)	DISTANCE TRAVELED (FEET)	SLOPE AVERAGE (PERCENT)
A 1.0 = 0.0742 AC	463.19	462.51	0.7	69.0	0.99
A 1.1 = 0.0432 AC	0.00	0.00	0.0	0.0	0.00
A 1.2 = 0.0279 AC	0.00	0.00	0.0	0.0	0.00
B 1.0 = 0.0256 AC	464.50	463.00	1.5	26.0	5.77
B 1.1 = 0.0695 AC	0.00	0.00	0.0	0.0	0.00
C 1.0 = 0.0209 AC	0.00	0.00	0.0	0.0	0.00
D 1.0 = 0.0187 AC	462.50	460.11	2.4	83.0	2.88
D 1.1 = 0.0457 AC	460.65	460.11	0.5	55.0	0.98
D 1.2 = 0.0387 AC	0.00	0.00	0.0	0.0	0.00
D 1.3 = 0.0186 AC	0.00	0.00	0.0	0.0	0.00
E 1.0 = 0.0122 AC	460.47	460.27	0.2	15.0	1.33
E 1.1 = 0.0182 AC	0.00	0.00	0.0	0.0	0.00
F 1.0 = 0.0224 AC	460.73	453.7	7.0	275.0	2.56
F 1.1 = 0.0965 AC	460.73	453.7	7.0	275.0	2.56
F 1.2 = 0.2674 AC	0.00	0.00	0.0	0.0	0.00
F 1.3 = 0.0213 AC	459.21	453.70	5.5	200.0	2.76

TABLE B4 - INITIAL TIME OF CONCENTRATION [T_i] OVER PROPOSED GRADE/SURFACES

DRAINAGE AREA (ACRES)	COMBINED FINAL WEIGHTED C FOR AREA	DISTANCE SURFACE TRAVEL (FEET)	MAX OVERLAND DISTANCE PER TABLE 3-2[1] (FEET)	REMAINING HEIGHT DIFFERENCE (FEET)	INITIAL TIME [T_i] FIGURE 3-4 (Minutes)
A 1.0 = 0.0742 AC	0.56	50	97	0.00	5.0
A 1.1 = 0.0432 AC	0.95	42	86	0.00	5.0
A 1.2 = 0.0279 AC	0.45	43	82	0.00	5.0
B 1.0 = 0.0256 AC	0.95	48	80	0.00	5.0
B 1.1 = 0.0695 AC	0.45	100	67	0.30	5.0
C 1.0 = 0.0209 AC	0.45	10	80	0.00	5.0
D 1.0 = 0.0187 AC	0.95	30	80	0.00	5.0
D 1.1 = 0.0457 AC	0.50	60	71	0.00	5.0
D 1.2 = 0.0387 AC	0.05	72	85	0.00	5.0
D 1.3 = 0.0188 AC	0.45	63	82	0.00	5.0
E 1.0 = 0.0122 AC	0.95	44	80	0.00	5.0
E 1.1 = 0.0182 AC	0.45	65	52	0.09	5.0
F 1.0 = 0.0224 AC	0.95	33	69	0.00	5.0
F 1.1 = 0.0965 AC	0.45	150	72	0.90	5.0
F 1.2 = 0.2674 AC	0.45	275	88	4.78	5.0
F 1.3 = 0.0213 AC	0.55	25	50	0.00	5.0

[1] INTERPOLATED DISTANCE VALUE

TABLE B5 - TIME OF CONCENTRATION [T_t] OVER PROPOSED GRADE/SURFACES

DRAINAGE AREA (ACRES)	REMAINING DISTANCE FROM TABLE B4 (FEET)	ADDITIONAL DISTANCE FROM TABLE B3 (FEET)	TOTAL TRAVEL DISTANCE FOR [T_t] (FEET)	REMAINING HEIGHT FROM TABLE B4 (FEET)	VERTICAL HEIGHT FROM TABLE B3 (FEET)	TOTAL HEIGHT [E] FOR [T_t] (FEET)	SLOPE [S] FOR [T_t] (%)	TIME OF TRAVEL [T_t] FIGURE 3-6 (Minutes)
A 1.0 = 0.0742 AC	0.0	69.0	69.0	0.0	0.7	0.7	1.0	4.1
A 1.1 = 0.0432 AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
A 1.2 = 0.0279 AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
B 1.0 = 0.0256 AC	0.0	26.0	26.0	0.0	1.5	1.5	5.8	0.0
B 1.1 = 0.0695 AC	33.0	0.0	33.0	0.3	0.0	0.3	0.9	3.4
C 1.0 = 0.0209 AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.5
D 1.0 = 0.0187 AC	0.0	83.0	83.0	0.0	2.4	2.4	2.9	0.0
D 1.1 = 0.0457 AC	0.0	55.0	55.0	0.0	0.5	0.5	1.0	0.0
D 1.2 = 0.0387 AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0
D 1.3 = 0.0188 AC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E 1.0 = 0.0122 AC	0.0	15.0	15.0	0.0	0.2	0.2	1.3	0.0
E 1.1 = 0.0182 AC	13.0	0.0	13.0	0.1	0.0	0.1	0.7	0.5
F 1.0 = 0.0224 AC	0.0	275.0	275.0	0.0	7.0	7.0	2.0	2.4
F 1.1 = 0.0965 AC	78.0	275.0	353.0	0.9	7.0	7.9	2.2	1.6
F 1.2 = 0.2674 AC	187.0	0.0	187.0	4.8	0.0	4.8	2.6	8.4
F 1.3 = 0.0213 AC	0.0	200.0	200.0	0.0	5.5	5.5	2.8	5.0
								1.4

TABLE B6 - TIME OF CONCENTRATION [T_c] SUMMARY

DRAINAGE AREA (ACRES)	TIME OF CONCENTRATION [$T_c = T_i + T_t$] (Minutes)
A 1.0 = 0.0742 AC	9.07
A 1.1 = 0.0432 AC	5.00
A 1.2 = 0.0279 AC	5.00
B 1.0 = 0.0256 AC	5.38
B 1.1 = 0.0695 AC	8.40
C 1.0 = 0.0209 AC	5.00
D 1.0 = 0.0187 AC	5.86
D 1.1 = 0.0457 AC	9.05
D 1.2 = 0.0387 AC	5.00
D 1.3 = 0.0188 AC	5.00
E 1.0 = 0.0122 AC	5.48
E 1.1 = 0.0182 AC	7.37
F 1.0 = 0.0224 AC	6.64
F 1.1 = 0.0965 AC	13.39
F 1.2 = 0.2674 AC	10.65
F 1.3 = 0.0213 AC	6.38

Note that the Initial Time of Concentration should be reflective of the general land-use at the upstream end of a drainage basin. A single lot with an area of two or less acres does not have a significant effect where the drainage basin area is 20 to 600 acres.

Table 3-2 provides limits of the length (Maximum Length (L_M)) of sheet flow to be used in hydrology studies. Initial T_i values based on average C values for the Land Use Element are also included. These values can be used in planning and design applications as described below. Exceptions may be approved by the "Regulating Agency" when submitted with a detailed study.

Table 3-2

MAXIMUM OVERLAND FLOW LENGTH (L_M)
& INITIAL TIME OF CONCENTRATION (T_i)

Element*	DU/	.5%		1%		2%		3%		5%		10%	
	Acre	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i	L_M	T_i
Natural		50	13.2	70	12.5	85	10.9	100	10.3	100	8.7	100	6.9
LDR	1	50	12.2	70	11.5	85	10.0	100	9.5	100	8.0	100	6.4
LDR	2	50	11.3	70	10.5	85	9.2	100	8.8	100	7.4	100	5.8
LDR	2.9	50	10.7	70	10.0	85	8.8	95	8.1	100	7.0	100	5.6
MDR	4.3	50	10.2	70	9.6	80	8.1	95	7.8	100	6.7	100	5.3
MDR	7.3	50	9.2	65	8.4	80	7.4	95	7.0	100	6.0	100	4.8
MDR	10.9	50	8.7	65	7.9	80	6.9	90	6.4	100	5.7	100	4.5
MDR	14.5	50	8.2	65	7.4	80	6.5	90	6.0	100	5.4	100	4.3
HDR	24	50	6.7	65	6.1	75	5.1	90	4.9	95	4.3	100	3.5
HDR	43	50	5.3	65	4.7	75	4.0	85	3.8	95	3.4	100	2.7
N. Com		50	5.3	60	4.5	75	4.0	85	3.8	95	3.4	100	2.7
G. Com		50	4.7	60	4.1	75	3.6	85	3.4	90	2.9	100	2.4
O.P./Com		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
Limited I.		50	4.2	60	3.7	70	3.1	80	2.9	90	2.6	100	2.2
General I.		50	3.7	60	3.2	70	2.7	80	2.6	90	2.3	100	1.9

*See Table 3-1 for more detailed description

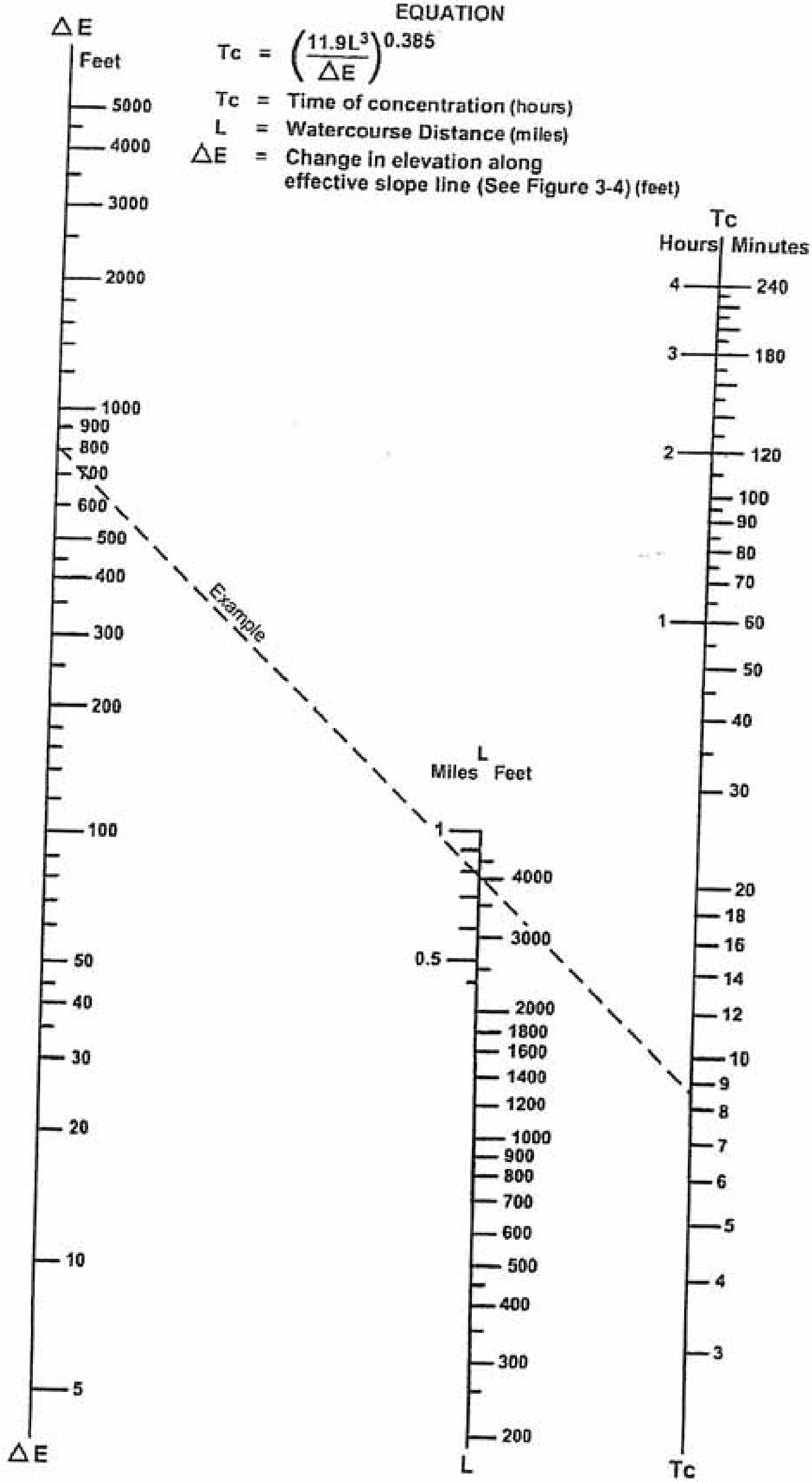
EQUATION

$$Tc = \left(\frac{11.9L^3}{\Delta E}\right)^{0.385}$$

Tc = Time of concentration (hours)

L = Watercourse Distance (miles)

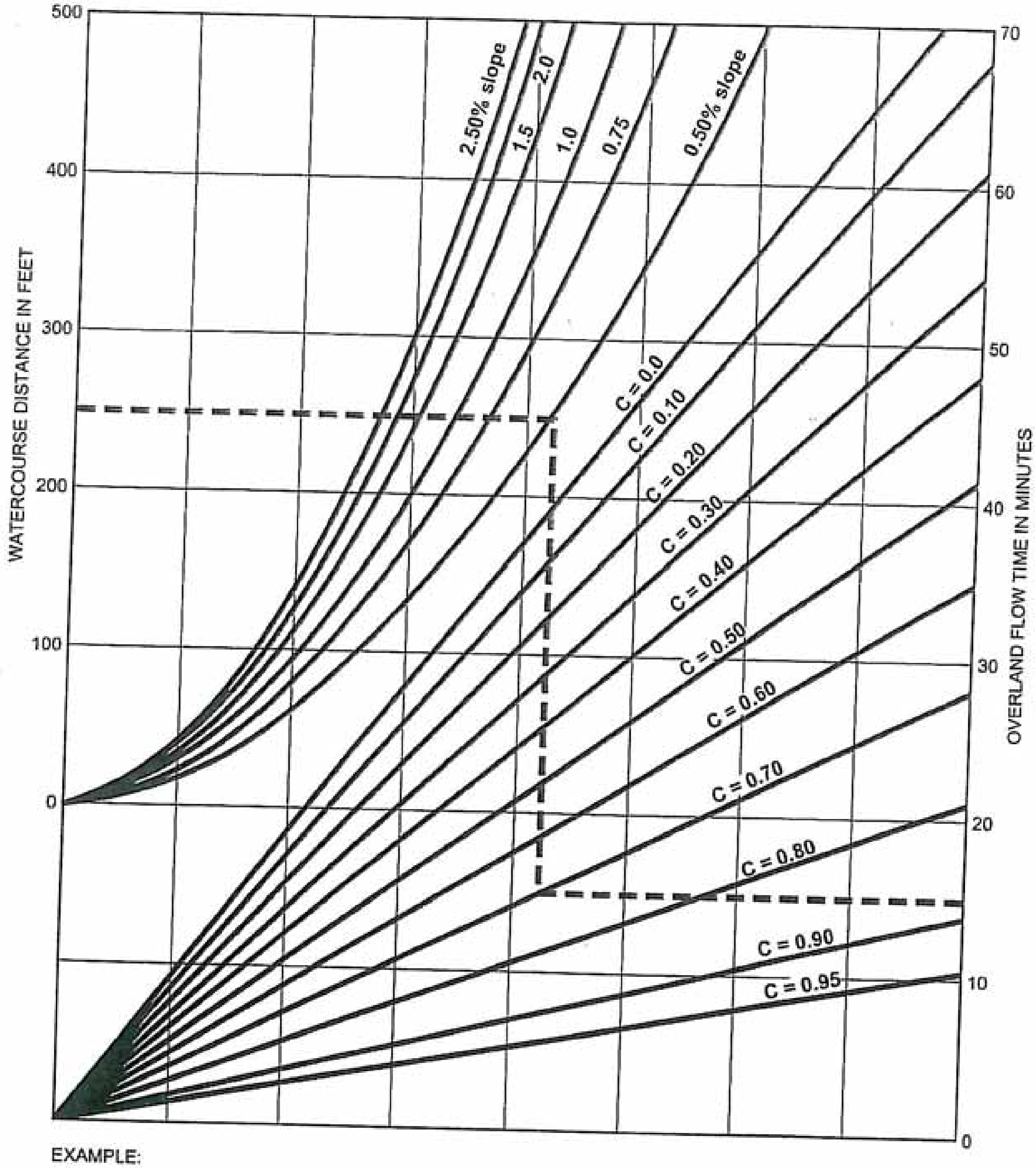
ΔE = Change in elevation along effective slope line (See Figure 3-4) (feet)



SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE **3-3**

Nomograph for Determination of Time of Concentration (Tc) for Natural Watersheds



EXAMPLE:

Given: Watercourse Distance (D) = 250 Feet
Slope (s) = 0.5%
Runoff Coefficient (C) = 0.70
Overland Flow Time (T) = 14.3 Minutes

$$T = \frac{1.8\,(1.1 - C)\sqrt{D}}{\sqrt[3]{s}}$$

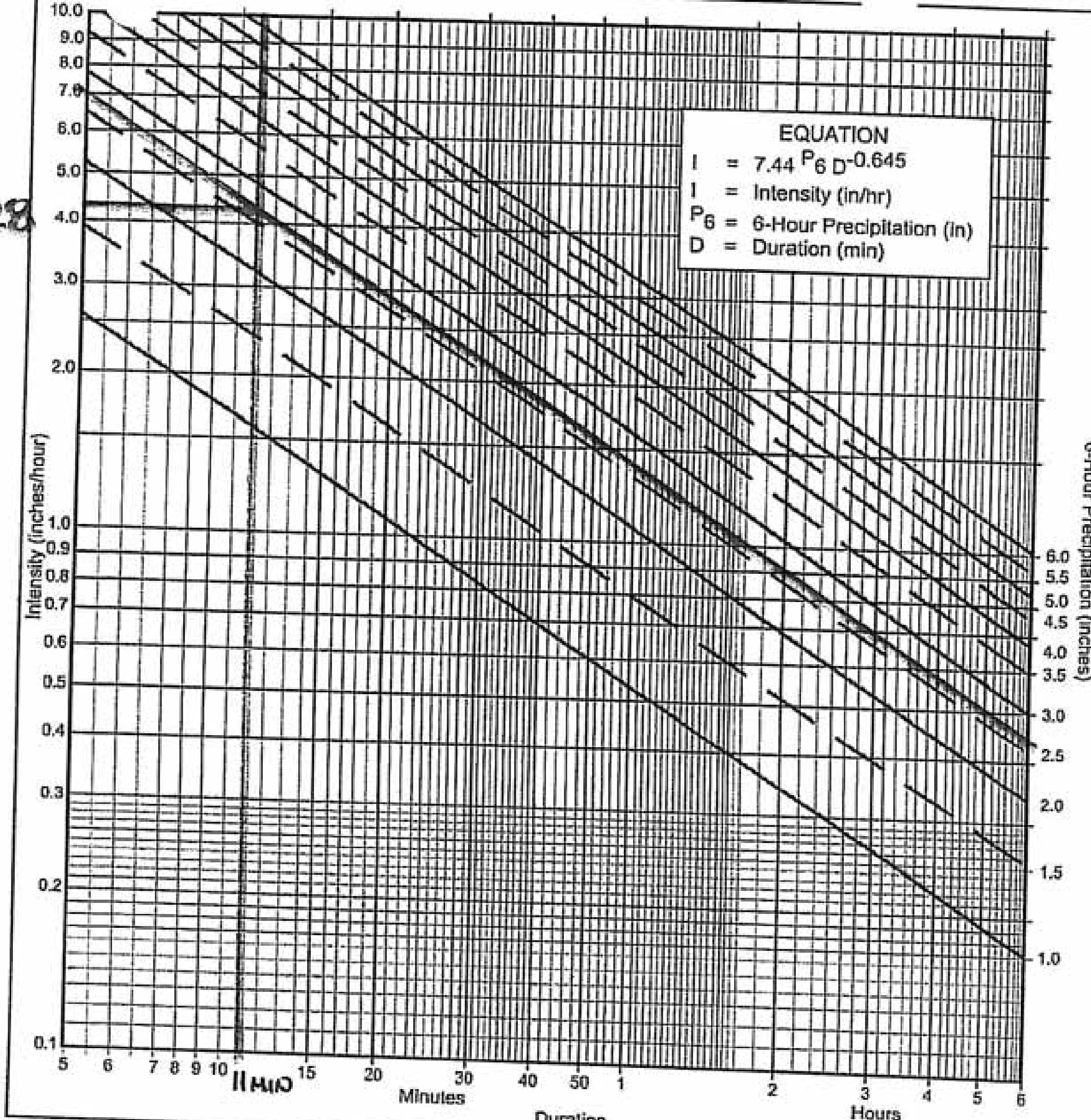
JRCE: Airport Drainage, Federal Aviation Administration, 1965

Rational Formula - Overland Time of Flow Nomograph

FIGURE

3-5

Existing ea A1.0



Directions for Application:

(1) From precipitation maps determine 6 hr and 24 hr amounts for the selected frequency. These maps are included in the County Hydrology Manual (10, 50, and 100 yr maps included in the Design and Procedure Manual).

(2) Adjust 6 hr precipitation (if necessary) so that it is within the range of 45% to 65% of the 24 hr precipitation (not applicaple to Desert).

(3) Plot 6 hr precipitation on the right side of the chart.

(4) Draw a line through the point parallel to the plotted lines.

(5) This line is the intensity-duration curve for the location being analyzed.

Application Form:

(a) Selected frequency 100 year

(b) P_6 = 2.7 in., P_{24} = 6.0 $\frac{P_6}{P_{24}}$ = 45 %[2]

(c) Adjusted $P_6^{(2)}$ = 2.7 in.

(d) t_x = 11.0 min.

(e) I = 4.28 in./hr.

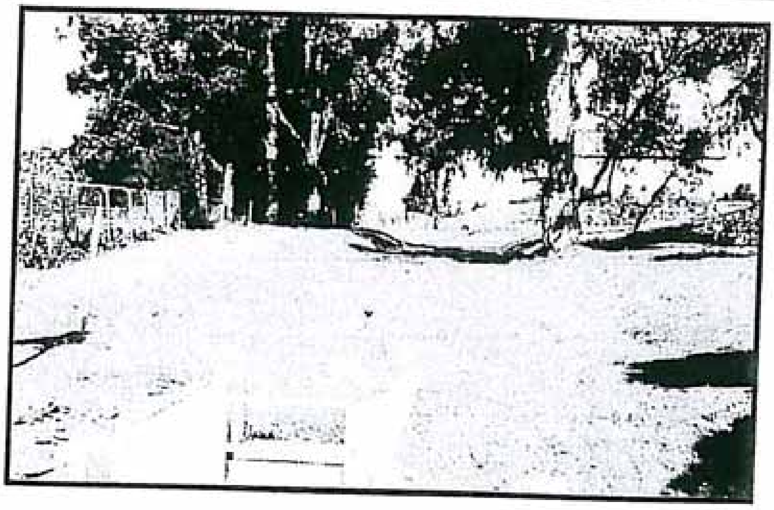
Note: This chart replaces the Intensity-Duration-Frequency curves used since 1965.

P6 / Duration	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6
	I	I	I	I	I	I	I	I	I	I	I
5	2.63	3.95	5.27	6.59	7.90	9.22	10.54	11.86	13.17	14.49	15.81
7	2.12	3.18	4.24	5.30	6.36	7.42	8.48	9.54	10.60	11.66	12.72
10	1.68	2.53	3.37	4.21	5.05	5.90	6.74	7.58	8.42	9.27	10.11
15	1.30	1.95	2.59	3.24	3.89	4.54	5.19	5.84	6.49	7.13	7.78
20	1.08	1.62	2.15	2.69	3.23	3.77	4.31	4.85	5.39	5.93	6.46
25	0.93	1.40	1.87	2.33	2.80	3.27	3.73	4.20	4.67	5.13	5.60
30	0.83	1.24	1.66	2.07	2.49	2.90	3.32	3.73	4.15	4.56	4.98
40	0.69	1.03	1.38	1.72	2.07	2.41	2.76	3.10	3.45	3.79	4.13
50	0.60	0.90	1.19	1.49	1.79	2.09	2.39	2.69	2.98	3.28	3.58
60	0.53	0.80	1.06	1.33	1.59	1.86	2.12	2.39	2.65	2.92	3.18
90	0.41	0.61	0.82	1.02	1.23	1.43	1.63	1.84	2.04	2.25	2.45
120	0.34	0.51	0.68	0.85	1.02	1.19	1.36	1.53	1.70	1.87	2.04
150	0.29	0.44	0.59	0.73	0.88	1.03	1.18	1.32	1.47	1.62	1.76
180	0.26	0.39	0.52	0.65	0.78	0.91	1.04	1.18	1.31	1.44	1.57
240	0.22	0.33	0.43	0.54	0.65	0.76	0.87	0.98	1.08	1.19	1.30
300	0.19	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94	1.03	1.13
360	0.17	0.25	0.33	0.42	0.50	0.58	0.67	0.75	0.84	0.92	1.00

Intensity-Duration Design Chart - Template

FIGURE

3-1



Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	●
☑	Metals	▲
☑	Bacteria	●
☑	Oil and Grease	▲
☑	Organics	▲

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

CASQA

- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

Construction/Inspection Considerations

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.

- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.

- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.

- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.

- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

Table 1 Grassed swale pollutant removal efficiency data							
	Removal Efficiencies (% Removal)						
Study	TSS	TP	TN	NO_3	Metals	Bacteria	Type
Caltrans 2002	77	8	67	66	83-90	-33	dry swales
Goldberg 1993	67.8	4.5	-	31.4	42–62	-100	grassed channel
Seattle Metro and Washington Department of Ecology 1992	60	45	-	-25	2–16	-25	grassed channel
Seattle Metro and Washington Department of Ecology, 1992	83	29	-	-25	46–73	-25	grassed channel
Wang et al., 1981	80	-	-	-	70–80	-	dry swale
Dorman et al., 1989	98	18	-	45	37–81	-	dry swale
Harper, 1988	87	83	84	80	88–90	-	dry swale
Kercher et al., 1983	99	99	99	99	99	-	dry swale
Harper, 1988.	81	17	40	52	37–69	-	wet swale
Koon, 1995	67	39	-	9	-35 to 6	-	wet swale

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

Selection Criteria (NCTCOG, 1993)

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

Summary of Design Recommendations

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.
- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.
- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.
- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.
- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

Cost

Construction Cost

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately \$0.25 per ft^2. This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately \$0.50 per ft^2, which compares favorably with other stormwater management practices.

Table 2 Swale Cost Estimate (SEWRPC, 1991)

Component	Unit	Extent	Unit Cost			Total Cost		
			Low	Moderate	High	Low	Moderate	High
Mobilization / Demobilization-Light	Swale	1	$107	$274	$441	$107	$274	$441
Site Preparation								
Clearing[b]	Acre	0.5	$2,200	$3,800	$5,400	$1,100	$1,900	$2,700
Grubbing[c]	Acre	0.25	$3,800	$5,200	$6,600	$950	$1,300	$1,650
General Excavation[d]	Yd³	372	$2.10	$3.70	$5.30	$781	$1,376	$1,972
Level and Till[e]	Yd²	1,210	$0.20	$0.35	$0.50	$242	$424	$605
Sites Development								
Salvaged Topsoil Seed, and Mulch[f]	Yd²	1,210	$0.40	$1.00	$1.60	$484	$1,210	$1,936
Sod[g]	Yd²	1,210	$1.20	$2.40	$3.60	$1,452	$2,904	$4,356
Subtotal	--	--	--	--	--	$5,116	$9,388	$13,660
Contingencies	Swale	1	25%	25%	25%	$1,279	$2,347	$3,415
Total	--	--	--	--	--	$6,395	$11,735	$17,075

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $\left(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}\right)$ x swale length (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

Table 3 Estimated Maintenance Costs (SEWRPC, 1991)

Component	Unit Cost	Swale Size (Depth and Top Width)		Comment
		1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width	3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width	
Lawn Mowing	$0.85 / 1,000 ft^2/ mowing	$0.14 / linear foot	$0.21 / linear foot	Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year
General Lawn Care	$9.00 / 1,000 ft^2/ year	$0.18 / linear foot	$0.28 / linear foot	Lawn maintenance area = (top width + 10 feet) x length
Swale Debris and Litter Removal	$0.10 / linear foot / year	$0.10 / linear foot	$0.10 / linear foot	–
Grass Reseeding with Mulch and Fertilizer	$0.30 / yd^2	$0.01 / linear foot	$0.01 / linear foot	Area revegetated equals 1% of lawn maintenance area per year
Program Administration and Swale Inspection	$0.15 / linear foot / year, plus $25 / inspection	$0.15 / linear foot	$0.15 / linear foot	Inspect four times per year
Total	--	$0.58 / linear foot	$ 0.75 / linear foot	–

Maintenance Cost

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

References and Sources of Additional Information

Barrett, Michael E., Walsh, Patrick M., Malina, Joseph F., Jr., Charbeneau, Randall J, 1998, "Performance of vegetative controls for treating highway runoff," *ASCE Journal of Environmental Engineering*, Vol. 124, No. 11, pp. 1121-1128.

Brown, W., and T. Schueler. 1997. *The Economics of Stormwater BMPs in the Mid-Atlantic Region.* Prepared for the Chesapeake Research Consortium, Edgewater, MD, by the Center for Watershed Protection, Ellicott City, MD.

Center for Watershed Protection (CWP). 1996. *Design of Stormwater Filtering Systems.* Prepared for the Chesapeake Research Consortium, Solomons, MD, and USEPA Region V, Chicago, IL, by the Center for Watershed Protection, Ellicott City, MD.

Colwell, Shanti R., Horner, Richard R., and Booth, Derek B., 2000. *Characterization of Performance Predictors and Evaluation of Mowing Practices in Biofiltration Swales.* Report to King County Land And Water Resources Division and others by Center for Urban Water Resources Management, Department of Civil and Environmental Engineering, University of Washington, Seattle, WA

Dorman, M.E., J. Hartigan, R.F. Steg, and T. Quasebarth. 1989. *Retention, Detention and Overland Flow for Pollutant Removal From Highway Stormwater Runoff. Vol. 1.* FHWA/RD 89/202. Federal Highway Administration, Washington, DC.

Goldberg. 1993. *Dayton Avenue Swale Biofiltration Study.* Seattle Engineering Department, Seattle, WA.

Harper, H. 1988. *Effects of Stormwater Management Systems on Groundwater Quality.* Prepared for Florida Department of Environmental Regulation, Tallahassee, FL, by Environmental Research and Design, Inc., Orlando, FL.

Kercher, W.C., J.C. Landon, and R. Massarelli. 1983. Grassy swales prove cost-effective for water pollution control. *Public Works*, 16: 53–55.

Koon, J. 1995. *Evaluation of Water Quality Ponds and Swales in the Issaquah/East Lake Sammamish Basins.* King County Surface Water Management, Seattle, WA, and Washington Department of Ecology, Olympia, WA.

Metzger, M. E., D. F. Messer, C. L. Beitia, C. M. Myers, and V. L. Kramer. 2002. The Dark Side Of Stormwater Runoff Management: Disease Vectors Associated With Structural BMPs. Stormwater 3(2): 24-39.Oakland, P.H. 1983. An evaluation of stormwater pollutant removal through grassed swale treatment. In *Proceedings of the International Symposium of Urban Hydrology, Hydraulics and Sediment Control, Lexington, KY.* pp. 173–182.

Occoquan Watershed Monitoring Laboratory. 1983. Final Report: *Metropolitan Washington Urban Runoff Project*. Prepared for the Metropolitan Washington Council of Governments, Washington, DC, by the Occoquan Watershed Monitoring Laboratory, Manassas, VA.

Pitt, R., and J. McLean. 1986. *Toronto Area Watershed Management Strategy Study: Humber River Pilot Watershed Project*. Ontario Ministry of Environment, Toronto, ON.

Schueler, T. 1997. Comparative Pollutant Removal Capability of Urban BMPs: A reanalysis. *Watershed Protection Techniques* 2(2):379–383.

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance: Recommendations and Design Considerations*. Publication No. 657. Water Pollution Control Department, Seattle, WA.

Southeastern Wisconsin Regional Planning Commission (SWRPC). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Technical report no. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI.

U.S. EPA, 1999, Stormwater Fact Sheet: Vegetated Swales, Report # 832-F-99-006 http://www.epa.gov/owm/mtb/vegswale.pdf, Office of Water, Washington DC.

Wang, T., D. Spyridakis, B. Mar, and R. Horner. 1981. *Transport, Deposition and Control of Heavy Metals in Highway Runoff*. FHWA-WA-RD-39-10. University of Washington, Department of Civil Engineering, Seattle, WA.

Washington State Department of Transportation, 1995, *Highway Runoff Manual*, Washington State Department of Transportation, Olympia, Washington.

Welborn, C., and J. Veenhuis. 1987. *Effects of Runoff Controls on the Quantity and Quality of Urban Runoff in Two Locations in Austin, TX.* USGS Water Resources Investigations Report No. 87-4004. U.S. Geological Survey, Reston, VA.

Yousef, Y., M. Wanielista, H. Harper, D. Pearce, and R. Tolbert. 1985. *Best Management Practices: Removal of Highway Contaminants By Roadside Swales*. University of Central Florida and Florida Department of Transportation, Orlando, FL.

Yu, S., S. Barnes, and V. Gerde. 1993. *Testing of Best Management Practices for Controlling Highway Runoff*. FHWA/VA-93-R16. Virginia Transportation Research Council, Charlottesville, VA.

Information Resources

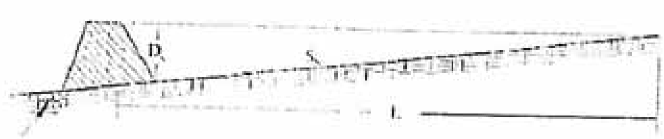
Maryland Department of the Environment (MDE). 2000. *Maryland Stormwater Design Manual*. www.mde.state.md.us/environment/wma/stormwatermanual. Accessed May 22, 2001.

Reeves, E. 1994. Performance and Condition of Biofilters in the Pacific Northwest. *Watershed Protection Techniques* 1(3):117–119.

Seattle Metro and Washington Department of Ecology. 1992. *Biofiltration Swale Performance.* Recommendations and Design Considerations. Publication No. 657. Seattle Metro and Washington Department of Ecology, Olympia, WA.

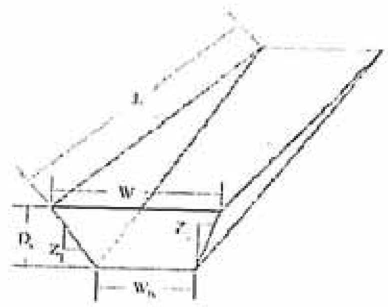
USEPA 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.* EPA-840-B-92-002. U.S. Environmental Protection Agency, Office of Water. Washington, DC.

Watershed Management Institute (WMI). 1997. *Operation, Maintenance, and Management of Stormwater Management Systems.* Prepared for U.S. Environmental Protection Agency, Office of Water. Washington, DC, by the Watershed Management Institute, Ingleside, MD.



Provide for scour protection.

(a) Cross section of swale with check dam.



Notation:

L = Length of swale impoundment area per check dam (ft)
D_s = Depth of check dam (ft)
S_s = Bottom slope of swale (ft/ft)
W = Top width of check dam (ft)
W_B = Bottom width of check dam (ft)
$Z_{1\&2}$ = Ratio of horizontal to vertical change in swale side slope (ft/ft)

(b) Dimensional view of swale impoundment area.

Inspection and Maintenance Checklist
Vegetated Swale

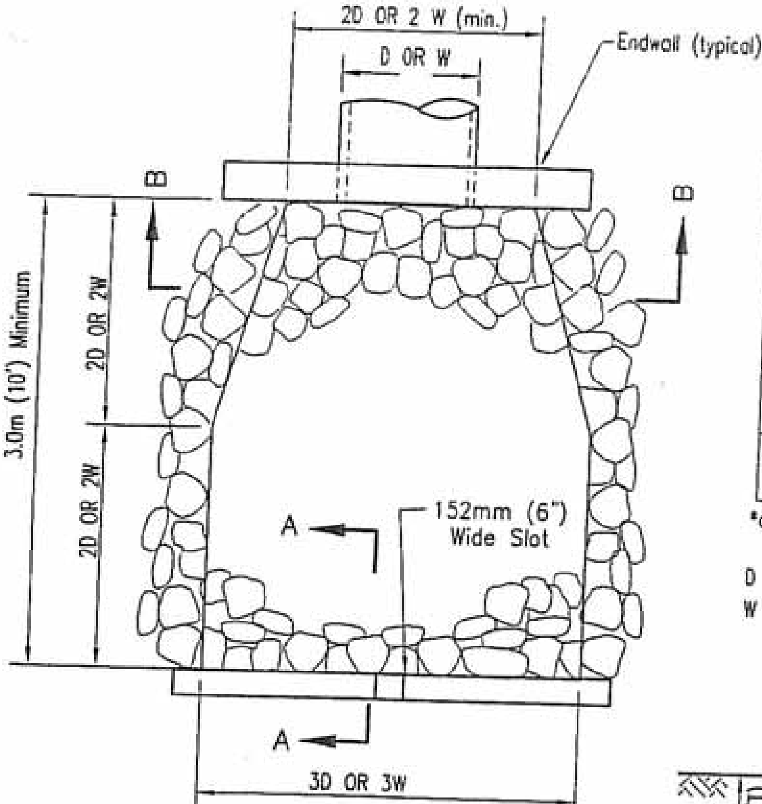
Property Address: ______________________ Property Owner: ______________________

Treatment Measure No.: __________ Date of Inspection: __________ Type of Inspection: ☐ Storm ☐ Monthly ☐ Quarterly ☐ Annual

Inspector(s): ______________________

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (If needed maintenance was not conducted, note when it will be done; or comment on any work that was done.)	Results Expected When Maintenance Is Performed
Sediment Accumulation on Vegetation	Sediment depth exceeds 2 inches.			Sediment deposits on vegetated treatment area of the swale removed. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
Standing Water	When water stands in the swale between storms and does not drain freely (does not drain within 72 hours)			There should be no areas of standing water once inflow has ceased. Any of the following may apply: sediment or trash blockages removed, improved grade from head to foot of swale, removed clogged check dams, added underdrains or converted to a wet swale.
Flow spreader (if any)	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.			Spreader leveled and cleaned so that flows are spread evenly over entire swale width.
Constant Base flow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.			No eroded, muddy channel on the bottom. A low-flow pea-gravel drain may be added the length of the swale.
Poor Vegetation Coverage	When planted vegetation is sparse or bare or eroded patches occur in more than 10% of the swale bottom.			Vegetation coverage in more than 90% of the swale bottom. Determine why growth of planted vegetation is poor and correct that condition. Re-plant with plugs of vegetation from the upper slope: plant in the swale bottom at 8-inch intervals, or re-seed into loosened, fertile soil.

Defect	Conditions When Maintenance Is Needed	Maintenance Needed? (Y/N)	Comments (If needed maintenance was not conducted, note when it will be done; or comment on any work that was done.)	Results Expected When Maintenance Is Performed
Vegetation	When the planted vegetation becomes excessively tall; when nuisance weeds and other vegetation start to take over.			Vegetation mowed per specifications or maintenance plan, or nuisance vegetation removed so that flow is not impeded. Vegetation should never be mowed lower than the design flow depth. Remove clippings from the swale and dispose appropriately.
Excessive Shading	Growth of planted vegetation is poor because sunlight does not reach swale.			Healthy growth of planted vegetation. If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.			Material removed so that there is no clogging or blockage in the inlet and outlet areas.
Trash and Debris Accumulation	Trash and debris accumulated in the swale.			Trash and debris removed from swale.
Erosion/ Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.			No erosion or scouring in swale bottom. For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.
Irrigation	Swale plants are dying because of improper irrigation.			Proper irrigation flow and timing to provide adequate, but not excessive, water to swale plants.
Vector Control	Conditions within swale provide mosquito breeding habitat.			Potential vectors abated by filling holes in the ground in and around the swale and by insuring that there are no areas where water stands longer than 72 hours following a storm.



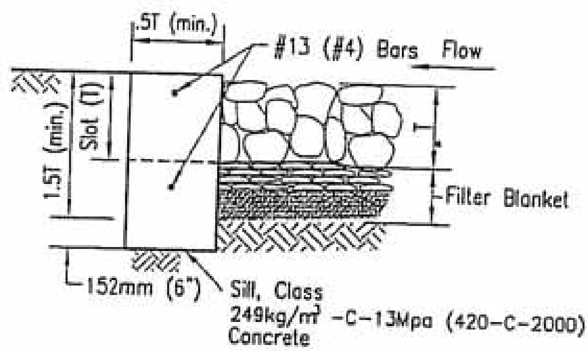
PLAN

Design Velocity m/sec (ft/sec)*	Rock Classification	T (min)
1.8–3 (6–10)	No. 2 Backing	320mm (1.1ft)
3–3.7 (10–12)	220 kg (1/4 ton)	823mm (2.7ft)
3.7–4.3 (12–14)	450 kg (1/2 ton)	1.1m (3.5ft)
4.3–4.9 (14–16)	900 kg (1 ton)	1.3m (4.4ft)
4.9–5.5 (16–18)	1.8 tonne (2 ton)	1.6m (5.4ft)

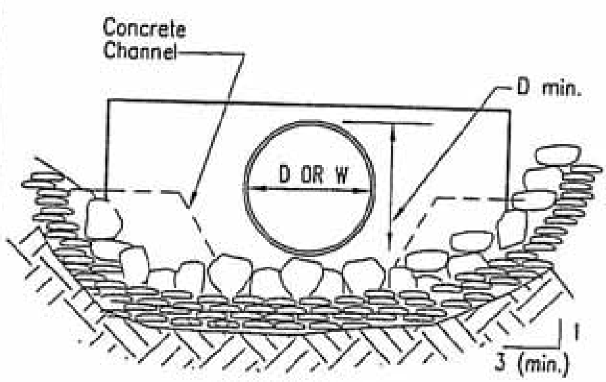
*over 5.5 mps (18 fps) requires special design

D = Pipe Diameter

W = Bottom Width of Channel



SECTION A–A



SECTION B–B

NOTES

1. Plans shall specify:
   A) Rock Class and thickness (T).
   B) Filter material, number of layers and thickness.
2. Rip rap shall be either quarry stone or broken concrete (if shown on the plans.) Cobbles are not acceptable.
3. Rip rap shall be placed over filter blanket which may be either granular material or filter fabric (woven filter slit film fabric shall not be used).
4. See Regional Supplement Amendments for selection of filter blanket.
5. Rip rap energy dissipators shall be designated as either Type 1 or Type 2. Type 1 shall be with concrete sill; Type 2 shall be without sill.

Revision	By	Approved	Date
ORIGINAL		Kercheval	12/75
Add [illegible]ric		T. Stanton	03/03
[illegible]		S. Brady	04/06

SAN DIEGO REGIONAL STANDARD DRAWING

RECOMMENDED BY THE SAN DIEGO REGIONAL STANDARDS COMMITTEE

RIP RAP
ENERGY DISSIPATOR

Chairperson R.C.E. 19246 Date

DRAWING NUMBER D-40

200-1.6.3 Quality Requirements

Page 45 - First paragraph, second sentence change "60 days" to "30 days".

200-1.7 Selection of Riprap and Filter Blanket Material

Table 200-1.7

Velocity Meters/Sec (Ft/Sec) (1)	Rock Class (2)	Rip Rap Thick-Ness "T"	Filter Blanket Upper Layer(s) (3)			
			Option 1 Sect. 200 (4)	Option 2 Sect.400 (4)	Option 3 (5)	Lower Layer (6)
2 (6-7)	No. 3 Backing	0.6	5 mm (3/16")	C2	D.G.	----
2.2 (7-8)	No. 2 Backing	1.0	6 mm (1/4")	B3	D.G.	----
2.6 (8-9.5)	Facing	1.4	9.5 mm (3/8")	----	D.G.	----
3 (9.5-11)	Light	2.0	12.5 mm (½")	----	25mm (3/4"- 1-1/2")	----
3.5 (11-13)	220 kg (1/4 Ton)	2.7	19 mm (3/4")	----	25mm (3/4"- 1-1/2")	SAND
4 (13-15)	450 kg (½ Ton)	3.4	25 mm (1")	----	25mm (3/4"- 1-1/2")	SAND
4.5 (15-17)	900 kg (1 Ton)	4.3	37.5 mm (1-1/2")	----	TYPE B	SAND
5.5 (17-20)	1.8Tonne (2 Ton)	5.4	50 mm (2")	----	TYPE B	SAND

See Section 200-1.6. see also Table 200-1.6 (A)

Practical use of this table is limited to situations where "T" is less than inside diameter.

(1) Average velocity in pipe or bottom velocity in energy dissipater, whichever is greater.

(2) If desired rip rap and filter blanket class is not available, use next larger class.

(3) Filter blanket thickness = 0.3 Meter (1 Foot) or "T", whichever is less.

(4) Standard Specifications for Public Works Construction.

(5) D.G. = Disintegrated Granite, 1mm to 10mm.

P.B. = Processed Miscellaneous Base.

ATTACHMENT F

OPERATION AND MAINTENANCE PROGRAM FOR TREATMENT BMP

(NOTE: INFORMATION REGARDING OPERATION AND MAINTENANCE CAN BE OBTAINED FROM THE FOLLOWING WEB SITE: HTTP://WWW.SDCOUNTY.CA.GOV/DPW/WATERSHEDS/LAND_DEV/SUSMP.HTML.)

ATTACHMENT G

CERTIFICATION SHEET

This Stormwater Management Plan has been prepared under the direction of the following Registered Civil Engineer. The Registered Civil Engineer attests to the technical information contained herein and the engineering data upon which recommendations, conclusions, and decisions are based.

DAVID McCARGAR REGISTERED CIVIL ENGINEER	**DATE**